Package: rvad (via r-universe)

November 2, 2024

Type Package

Title Velocity Azimuth Display of Meteorological Radars

Version 0.1.0

Description This package implement an algorithm to process radial wind from Doppler radars obtainning the proper horizontal wind. The implementation is based on Browning and Wexler (1968) <doi:10.1175/1520-0450(1968)007%3C0105:TDOKPO%3E2.0.CO;2> with the addition of several quality controls.

License GPL-3

URL https://github.com/paocorrales/rvad

BugReports https://github.com/paocorrales/rvad/issues

Encoding UTF-8

LazyData true

Depends R (>= 2.10)

Imports data.table

Suggests ggplot2

Roxygen list(markdown = TRUE)

RoxygenNote 6.1.1

Repository https://paocorrales.r-universe.dev

RemoteUrl https://github.com/paocorrales/rvad

RemoteRef HEAD

RemoteSha 31d393d3feaff22fb56a43da8b7ed510f16530bd

Contents

`beam_propagation` *Radar beam propagation*

Description

Calculates the propagation of the radar beam using the 4R/3 approximation.

Usage

```
beam_propagation(range, elevation, R = 6371000, Rp = 4 * R/3)
```

Arguments

`range`	vector with the distance to the radar en meters.
`elevation`	vector of the same length as `range` containing elevation angles in degrees.
`R`	radius of Earth in meters.
`Rp`	aproximation used.

Value

A data frame conteing 3 variables:

ht height above the radar in meters.

rh horizontal range in meters.

lea local elevation angle in degrees.

`radial_wind` *One volume of radial velocity*

Description

A single volume of radial velocity measured on January 14th 2016 between 06:00:05 and 06:04:31 at Paraná, Entre Ríos.

Usage

```
radial_wind
```

Format

A `data.table` with 2076960 rows and 4 variables:

range distance to de radar in meters

vr radial velocity in m/s

azimuth azimuth angle in degrees

elevation elevation angle in degrees

Source

https://radar.inta.gob.ar/

`vad_fit` *Velocity Azimuth Display*

Description

Approximates the horizontal components of the wind from radial wind measured by Doppler radar using the Velocity Azimuth Display method from Browning and Wexler (1968).

Usage

```
vad_fit(radial_wind, azimuth, range, elevation, max_na = 0.2,
  max_consecutive_na = 30, r2_min = 0.8, outlier_threshold = Inf,
  azimuth_origin = 90, azimuth_direction = c("cw", "ccw"))
```

Arguments

`radial_wind` a vector containing the radial wind.

`azimuth` a vector of length = length(radial_wind) containing the azimuthal angle of every radial_wind observation in degrees clockwise from 12 o' clock.

`range` a vector of length = length(radial_wind) containing the range (in meters) asociate to the observation.

`elevation` a vector of length = length(radial_wind) with the elevation angle of every observation in degrees.

`max_na` maximum percentage of missing data in a single ring (defined as the date in every range and elevation angle).

`max_consecutive_na` maximun angular gap for a single ring.

`r2_min` minimum r squared permitted in each fit.

`outlier_threshold` threshhold for removing outliers in standard deviation units

`azimuth_origin` angle that represents the zero azimuth in degrees counterclockwise from the x axis.

`azimuth_direction` direction of the azimuth angle.

Details

The algorithm can work with sigle volume of data scanned in PPI (Plan Position Indicator) mode. The radial wind must not have aliasing. Removing the noise and other artifacts is desirable.

`vad_fit()` takes vectors of the same length with radial wind, azimuth angle, range and elevation angle and computes a sinusoidal fit for each ring of data (the observation for a particular range and elevation) before doing a simple quality control.

First, it checks if the amount of missing data (must be explicit on the data frame) is greater than `max_na`, by default a ring with more than 20 data is descarted. Second, rejects any ring with a gap greater than `max_consecutive_na`. Following Matejka y Srivastava (1991) the default is set as 30 degrees. After the fit, the algorithm rejects rings whose fit has a `r2` less than `r2_min`. It is recommended to define this threshold after exploring the result with `r2_min = 0`.

Rings that fail any of the above-mentioned checks return `NA`.

Value

A data frame with class `rvad_vad` that has a `plot()` method and contains 7 variables:

height height above the radar in meters.

u zonal wind in m/s.

v meridional wind in m/s.

range distance to the radar in meters.

elevation elevation angle in degrees.

r2 r squared of the fit.

rmse root mean squared error calculated as the standar deviation of the residuals.

See Also

`vad_regrid()` to sample the result into a regular grid.

Examples

```
VAD <- with(radial_wind, vad_fit(radial_wind, azimuth, range, elevation))
plot(VAD)
```

`vad_regrid` *Wind profile from VAD*

Description

Aggregates the result of `vad_fit()` using a modified loess smooth of degree 1 to get a wind profile on a regular (or other user-supplied) grid.

Usage

```
vad_regrid(vad, layer_width, resolution = layer_width, ht_out = NULL,
  min_n = 5)
```

Arguments

vad	an rvad_vad object returned by vad_fit().
layer_width	width of the layers in meters (see Details).
resolution	vertical resolution in meters.
ht_out	vector of heights where to evaluate. Overrides resolution.
min_n	minimum number of points in each layer.

Details

The method approximates wind components in a regular grid using weighted local regression at each point in the grid. Unlike stats::loess(), the layer_width is specified in physical units instead of in ammount of points and thus the value at each gridpoint represents the wind at a layer of thickness layer_width. This means that, while the resolution parameter determines how many points are used to define the wind profile, the effective resolution is controlled by layer_width. Increasing layer_width results in more precise estimates (because it's basedon more data points) but reduces the effective resolution.

Value

A data frame with class rvad_vad that has a plot() method and contains 7 variables:

height height above the radar in meters.

u zonal wind in m/s.

v meridional wind in m/s.

u_std.error standar error of u in m/s.

v_std.error standar error of v in m/s.

Examples

```
VAD <- with(radial_wind, vad_fit(radial_wind, azimuth, range, elevation))

# Wind profile with effective resolution of 100
plot(vad_regrid(VAD, layer_width = 100, resolution = 100))
# The same effective resoution, but sampled at 50m
plot(vad_regrid(VAD, layer_width = 100, resolution = 50))

# Using too thin layers can cause problems and too many
# mising values
plot(fine_resolution <- vad_regrid(VAD, layer_width = 10))
mean(is.na(fine_resolution$u))
```

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